

EVA HEALTH AND HUMAN PERFORMANCE BENCHMARKING STUDY

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INTRODUCTION

Multiple HRP Risks and Gaps require detailed characterization of human health and performance during exploration extravehicular activity (EVA) tasks; however, a rigorous and comprehensive methodology for characterizing and comparing the health and human performance implications of current and future EVA spacesuit designs does not exist. This study will identify and implement functional tasks and metrics, both objective and subjective, that are relevant to health and human performance, such as metabolic expenditure, suit fit, discomfort, suited postural stability, cognitive performance, and potentially biochemical responses for humans working inside different EVA suits doing functional tasks under the appropriate simulated reduced gravity environments. This study will provide health and human performance benchmark data for humans working in current EVA suits (EMU, Mark III, and Z2) as well as shirtsleeves using a standard set of tasks and metrics with quantified reliability. Results and methodologies developed during this test will provide benchmark data against which future EVA suits, and different suit configurations (eg, varied pressure, mass, CG) may be reliably compared in subsequent tests. Results will also inform fitness for duty standards as well as design requirements and operations concepts for future EVA suits and other exploration systems.

SPECIFIC AIMS

Phase 1: EVA Health & Human Performance Benchmarking Protocol Development & Validation

Use 1g testing in shirtsleeve and Mark III to identify the tasks, methods, and metrics (including biomechanical, physiological, cognitive, neurovestibular, and biochemical) that will be used during subsequent benchmarking; quantify measurement reliability.

Phase 1b: NBL Protocol Development

Leverage existing collaborations with the EVA Management Office to develop an IRB-approved NBL-version of the EVA Health & Human Performance Benchmarking Protocol.

Phase 2: Reduced Gravity Multi-Suit Benchmarking

Use selected tasks, methods, and metrics from Phase 1 to conduct a study using the active response gravity offload system (ARGOS) to compare the EMU, Mark III, and Z2 spacesuits and a shirtsleeves baseline. Establish and compare performance benchmarks for current EVA suits and characterize differences in human performance benchmarking measures associated with different suit system design parameters.

RESEARCH METHODS

Plan and execute a multi-phase study design that includes a minimum of 6 subjects and 3 EVA suits. Define representative exploration EVA tasks, functional movements, and multi-disciplinary assessment methodology using a 1g baseline followed by simulated partial gravity conditions. A subset of tasks that do not involve whole-body movements may be conducted using static offloading (eg, A-frame) if necessary for cost or ARGOS availability reasons. Design and fabricate necessary suit/ARGOS interface elements and test apparatus to enable study (eg, improved suited gimbal) if necessary. Incorporate suit trauma countermeasure garments and/or suit sensors if available and if possible without confounding primary study objectives.

MULTIDISCIPLINARY APPROACH

The EVA HHP Benchmarking Study is intended to incorporate all relevant HHP disciplines and includes subject matter experts from multiple laboratories and organizations within the HHP directorate. Furthermore, the study is being coordinated with the broader EVA community to ensure relevance and buy-in; indeed, definition of exploration EVA functional tasks for the study is being funded directly by the EVA office.